A system dynamics model of post-earthquake reconstruction pathways

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Background

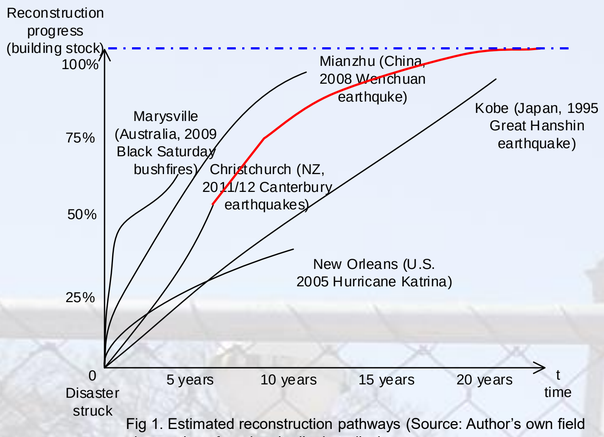

Fig 1. Estimated reconstruction pathways (Source: Author's own field observations from longitudinal studies)

Question: What fundamentally differentiates the rebuilding time path of Christchurch from that of other places? Like Kobe and New Orleans?

Research Aim

To gain a full understanding of the underlying mechanisms and processes that drive reconstruction progression and integrate such understanding in real-time decision making.

Objectives

- To develop a system dynamics model of Christchurch post-quake reconstruction process that captures all the critical dynamics influencing its pathway
- To investigate the implications of current rebuild pathway
- To build a reconstruction module to be integrated in MERIT (Measuring the Economics of Resilient Infrastructure Tool)

Conceptual model of earthquake reconstruction process

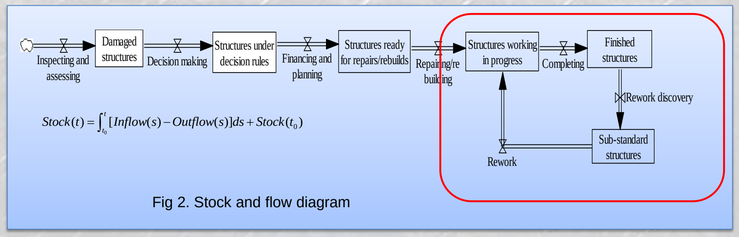

Fig 2. Stock and flow diagram

The methodological core of research strategy

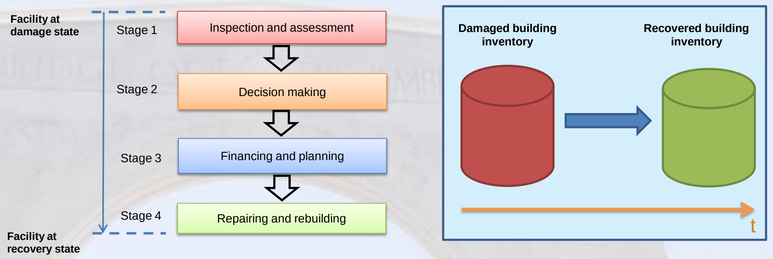

Fig 3. Simulating reconstruction process

The system dynamic modelling is to *investigate how a given building stock of a similar type (i.e. governed by similar decision rules) changes over the reconstruction period from the damage state to a full recovery state.*

Results

The mechanisms that affect the time-path of post-earthquake reconstruction fall into four categories

- Planning and regulatory environment
- Capability of engineering and construction sector
- Financing mechanism (e.g. insurance settlement)
- Decision making and actions of facility owners

$$T_D(i,j) = \alpha_{0,j} + \sum_{m=1}^{p} \alpha_{m,j} * k_{m,j} + \sum_{n=1}^{q} \beta_{n,j} * IT_{n,j} + \varepsilon_{i,j}$$

Mathematical relationship between the time delay as a dependent variable and its critical contributing factors/mechanisms which are the independent endogenous variables

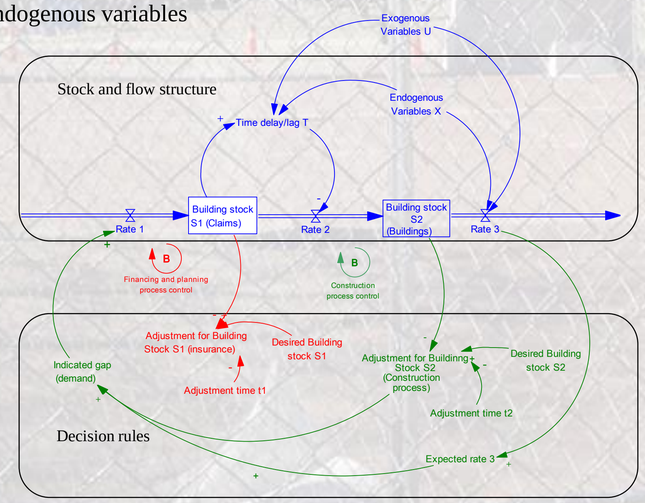

Fig 4. The stock management structure

System dynamics model of residential repairs and rebuilds

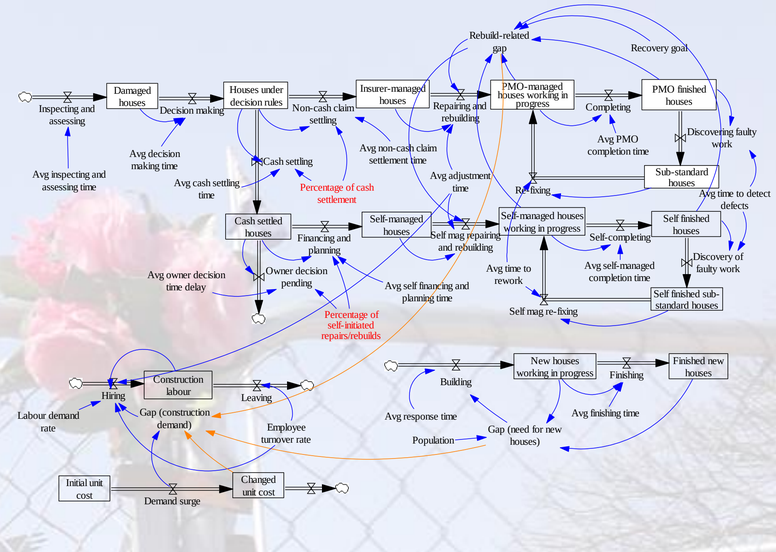

Fig 5. System dynamics housing rebuild model and simulation results

Conclusions

- Reconstruction is driven by regulation and insurance.
- Oscillation type of system behaviour shows the unstable response from the construction sector.
- The feedback loop shows there is a delay in construction demand landing for real construction which cause incorrect demand perception.
- A better construction information reporting system **(not using lagging metrics)** is needed to improve the reconstruction planning and expedite the reconstruction process.

Acknowledgement

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